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ABSTRACT

Evolving from concern for the increasing requirements for literacy, especially visual literacy, the purpose of this study was to determine the impact of color on learning. Sixty midwestern college students were assigned to groups where they read and studied a graphic presentation, and then were tested on their recall and retention. The following independent variables were manipulated to determine relationships with recall and retention: (1) type of graphic presentation; i.e. systematically color-cued or black/white; (2) assessment types; i.e. systematically color-cued or black/white; and (3) time of testing; either immediate recall or two-week delayed retention. The dependent variable, recall/retention on the assessment graphic, was measured by achievement, the number of characters, actions, and explanations that were remembered and recorded on a graphic presentation summarizing a little-known Norse myth. Results failed to show a significant three-way interaction among the graphic presentation, graphic assessment, and time of testing. Furthermore, results did not indicate a significant two-way interaction between presentation type and graphic assessment type. The use of color did not have an impact on the recall and retention of verbal information presented in graphic form. Implications for future research are suggested. Data is presented in one figure and three tables. (Contains 18 references.) (MAS)

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The Role of Color in Remembering Graphically Presented Information

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Prior knowledge of the world, language, and text provides a rich background for the adult reader. A sophisticated understanding of mature reading cuts through the controversies of emergent and early literacy, ranging from the importance of whole languge to the potential of phonics instruction, and focuses on the literacy task of processing visual information. Sticht and McDonald (1992) state that most adult readers in a literate society possess some knowledge of the functional uses of written language and of graphic devices. Awareness and use of the fundamental features of graphic displays are essential to literacy. Although a diversity of charts, lists, and categories of graphic features can be found in the literature, all recognize the feature of color. Kueppers (1992) states that because visual data consist primarily of shape data and color data, one can assume that 40% of all information perceived consists of information about color. Despite its significance as a source of information and as an aesthetic expression, students learn little about color in school. A minimum of direct instruction may include information about the color spectrum, the color circle, the laws of color mixing, and a few references to the uses of color in literature; however, instruction concerning the understanding and use of color in learning is largely missing from the curriculum of elementary and secondary schools, colleges and technical schools (Kueppers, 1982; Robinson, 1991).

This is the fourth study in a line of research to determine the impact of color on learning. These studies evolved from the researcher's concern for the increasing requirements of literacy (Venezky, 1990); among those requirements is visual literacy, the ability to understand and make visual messages (Dondis, 1973). This line of research has focused on the potential for and reluctance of educators to manipulate and interact with the features or characteristics of graphics (Sticht & McDonald, 1992) and to consider instruction aimed at developing visual literacy at all levels as essential across the curriculum (Robinson, 1991).

Research does not clearly guide instruction although a research base exists. From the noteworthy, classic studies of Dwyer and Lamberski (1982-83) has evolved a body of research based on the study of color-coded materials of the chambers of the heart. Subsequent studies have researched the effects of visual attributes on learning (Dwyer, 1978, 1987) although a limited number of graphic forms have been used. This line of research has attempted to broaden the scope of research by using a systematic color code in a unique graphic for which subjects have no prior schema (Pruisner, 1992). Additionally, the second study (Pruisner, 1993) attempted to further isolate color as applied to learning from graphics by eliminating the oral retelling of the myth used prior to the reading of the myth and accompanying the graphic in the first study. The third study (Pruisner, 1994) utilized the same color-coded plan in preparing the graphic for presentation and assessment, but the code was not explained to the students. Consequently, the color appeared as a cue rather than a

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code. This fourth study employed the same color-coded graphic presented as a color cue, but the color saturation was matched across the three colors. Furthermore, the target population was college-level readers.

Methodology

Statement of the problem

In response to the contemporary reader's need to interpret graphics in our broad information environment, research stresses the need for and importance of well-designed graphics (Gerber, 1985; Kostelnick, 1988; Peterson, 1983). Empirical research needs to be conducted to determine the effects of the manipulation of graphic features on reading (Hartley, 1986), graphical comprehension (Peterson, 1983; Soderston, 1983), and their application to instruction (Pearson, Roehler, Dole & Duffy, 1992).

Research Questions

The following research questions were investigated in all four studies in this line of research with changes only in reference to color coding and color cuing:

1. Is there a significant interaction among the graphic presentation type (systematically color-cued or black/white), the graphic assessment type (systematically color-cued or black/white), and the time of testing (immediate recall or delayed retention) of verbal material?

2. Is there a significant interaction between the graphic presentation type (systematically color-cued or black/white) and the graphic assessment type (systematically color-cued or black/white) when immediate recall of verbal material is tested?

3. Is there a significant interaction between the graphic presentation type (systematically color-cued or black/white) and the graphic assessment type (systematically color-cued or black/white) when delayed retention of verbal material is tested?

4. Is there a significant difference in recall of verbal material between those given a systematically color-cued graphic presentation and those given a black/white graphic presentation?

5. Is there a significant difference in retention of verbal material between those given a systematically color-cued graphic presentation and those given a black/white graphic presentation?

6. Is there a significant difference in recall of verbal material between those given a systematically color-cued graphic assessment and those given a black/white graphic assessment?

7. Is there a significant difference in retention of verbal material between those given a systematically color-cued graphic assessment and those given a black/white graphic assessment?

Research Design

An analysis of variance for repeated measures was used to test the hypotheses that significant interactions and differences would occur. The independent variables manipulated were the type of graphic presentation, the type of graphic assessment, and the time of testing. The two presentation and assessment types were systematically color-cued and black/white, and the two times of testing included immediate recall and 2-week delayed retention. The dependent variable, recall/retention on the assessment graphic, was measured by achievement, the number of characters, actions, and explanations that were remembered and recorded as stated on a graphic presentation summarizing a little-known Norse myth. To accommodate three independent variables, with two levels each, a 2x2x2 (presentation x assessment x time of testing) was used. Presentation type and assessment type were the between-subjects factors, and recall/retention was the within-subjects factor.

Subjects

The subjects, 60 college students from a small, Midwest liberal arts college, were randomly assigned to one of four treatment groups (adjusted n = 15).

Treatment Groups

The four treatment groups received the following:

1. Color-cued presentation, color-cued assessment
2. Color-cued presentation, black/white assessment
3. Black/white presentation, color-cued assessment
4. Black/white presentation, black/white assessment.

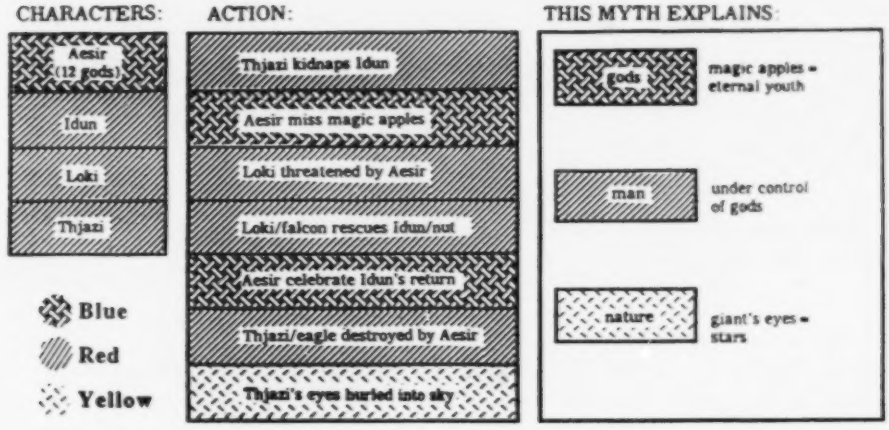
Procedure

During session one, all students received directions via audiotape; they then read and studied the graphic presentation in isolation. Subjects demonstrated both immediate recall and 2-week delayed retention on the graphic assessment without the aid of the presentation graphic.

Materials

Following the directions, subjects were given the presentation graphic. The graphic design was the same on all presentations and assessments (see Figure 1). The form of the graphic was a unique design created by the researcher to prevent the subjects from having prior experience with the graphic.

Figure 1. Sample of graphic presentation indicating the use of color.



Scoring of the instrument

All assessments were scored by two raters to ensure accuracy. One point was given for each acceptable word or synonym. One point was given for each box or area where all words were written in order and spelled correctly. One point was given for each word or phrase that was placed in the correct box or area.

Empirical Results

Based on the results of the analysis of variance with the level of significance established at the .05 level, there was not a significant three-way interaction among the graphic presentation and the graphic assessment and the time of testing (see Table 1). The supporting evidence, the means and standard deviations for the four treatment groups, is graphically displayed in Table 2.

Table 1.

Repeated Measures Analysis of Variance, MANOVA Test Criteria and Exact F Statistics

	Value	F	Prob.	Sig.
Time x presentation	.99	.25	.62	NS
Time x assessment	.99	.11	.74	NS
Time x presentation x assessment	.99	.27	.61	NS

Table 2.

Mean Performance at Recall and Retention for Each Treatment Group

Group	Time of Testing			
	Recall		Retention	
	M	SD	M	SD
Color presentation				
Color assessment	73.53	(10.74)	33.13	(21.65)
Black/white assessment	69.00	(11.12)	27.67	(22.81)
Black/white presentation				
Color assessment	73.67	(5.96)	28.07	(16.23)
Black/white assessment	70.00	(10.55)	28.73	(19.28)

Note. n = 15 for each group.

Furthermore, the analysis of variance for between subjects effects did not indicate the presence of a significant two-way interaction between presentation type and graphic assessment type. No significant factors were identified (see Table 3).

Table 3.

Analysis of Variance, Tests of Hypotheses for BetweenSubjects Effects

Source of of variation	df	Sum of squares	Mean square	F	Prob.	Sig.
Presentation	1	15.41	15.41	.05	.82	NS
Assessment	1	316.88	316.88	1.03	.32	NS
Presentation x Assessment	1	91.88	91.88	.30	.59	NS

Empirically, there were no significant findings of this study: no important single factor or interaction was identified as enhancing performance.

Recommendations for Practice

In this study the use of color did not have an impact on the recall and retention of verbal information presented in graphic form. However, the notation of the color names on three of the black/white graphic assessments clearly indicates that some students use a color strategy to facilitate recall and retention. Overall, the achievement of subjects indicates they effectively use strategies or techniques to enhance performance, but the use of color as a feature of graphics does not increase recall and retention when presented as a color cue. These observations indicate the use of color in graphics should still be considered when developing curriculum, planning instruction, and designing text. The belief that a color-coding process may enable learners to retain critical information (Pettersson, 1993) needs to be further explored in both educational practice and research.

Implications for Future Research

To continue this line of research, it is recommended that future study focus on color and graphics. The results of further research would provide valuable information for readers, teachers, and designers of curricular materials at all levels of the learning spectrum:

1. Further research should investigate the effects of the use of a color code in graphically presented information when the use of the color code is explained to adult readers. The results would have an impact on the importance of direct instruction concerning the color-coding process.

2. Additional studies at varying levels should manipulate the characteristics of graphics, including new and familiar graphic presentations and different colors and numbers of colors. This should determine the comparative efficacy of varying graphic features in tapping and developing schemata.

3. Research should be conducted to investigate how skilled elementary, secondary, and adult readers use color and other features of graphics to remember patterns in schemata. This research should include quantitative, as well as qualitative research and case studies of readers of varying ages who are considered to be at an expert level. The results would have implications for the graphic schema strategies we teach.

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